

Agroforestry and the Family Farm: 'A Farm is a Place to Live'

*2008 Annual Report:
Research, Partnerships & Technology Transfer*

Center for Agroforestry
University of Missouri



*Enhancing Stewardship, Farm Profitability,
Biodiversity & Wildlife Habitat*

ABOUT THE CENTER

What is Agroforestry?

Agroforestry provides new market opportunities and is a form of sustainable agriculture, land stewardship and habitat for wildlife. It can provide improved water quality and diversified farm income.

In simple terms, agroforestry is intensive land-use management combining trees and/or shrubs with crops and/or livestock.

Agroforestry helps landowners diversify products, markets and farm income; improve soil and water quality; and reduce erosion, non-point source pollution and damage due to flooding. The five integrated practices of agroforestry enhance land and aquatic habitats for fish and wildlife and improve biodiversity while sustaining land resources for generations to come.

The University of Missouri Center for Agroforestry (UMCA), established in 1998, is one of the world's leading centers contributing to the science underlying agroforestry. Interdisciplinary collaboration is one of the hallmarks of the Center. Research on the benefits of agroforestry is supported from a broad spectrum of disciplines across the university.

Linked with the Center's solid science and research programs are several key collaborations and partnerships with landowners, natural resource professionals, federal and state agencies and non-profit organizations. Through these critical relationships, UMCA and its partners are producing an expanding list of positive outcomes for landowners, the natural environment and society as a whole.

UMCA'S GOALS

Through research, field application and technology transfer, demonstrate agroforestry's ability to

- Develop new market opportunities
- Generate income
- Reduce non-point source pollution
- Mitigate against impacts of periodic flooding
- Create and improve wildlife habitat
- Sequester carbon
- Develop bio-energy crops

The Center represents the state-of-the-art in agroforestry, incorporating all we have learned in our research and from our collaborators and putting it into practice for the benefit of the family farm. However our efforts don't stop at research; the Center is truly unique in that we actively work to get the word out about agroforestry and into the hands of landowners through collaboration, workshops, informational exhibits, newsletters and other publications. We work jointly with landowners to create farms that are profitable, sustainable and beautiful; truly a place to live.



RESEARCH HIGHLIGHTS 2008

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*Edited by Michelle Hall, UMCA Senior Information Specialist, ☺
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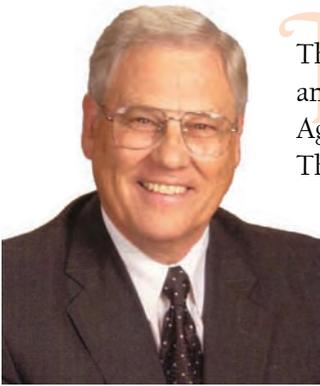


Photo: Roger Berg's Creative Photo, Inc.

The family farm is in need of help and this is the focal point for our Agroforestry Center's activities. The face of rural America has changed from a constellation of small family farms banding together to meet the food needs of our nation to one dominated by large corporate farms producing surpluses that help feed millions abroad.

As a result, many family farms are struggling just to turn a profit. Those who have tried to compete in the conventional commodity markets have quickly realized that it is very difficult, forcing husband and wife teams to leave their profession of choice and seek employment away from the farm just to make ends meet. Found within family farm communities are millions of acres of "under-used" land ideally suited for the application of agroforestry. These lands not only can be used to grow timber products that will always be in high demand, but can be used to address an increasing demand for "local, healthier" food for which the demand is beginning to exceed the supply, along with other "niche" crops of high economic value. In return for adopting agroforestry, family farm owners greatly improve their finances and in the process retain a way of life that has been handed down from one generation to the next. Long term, there is a guaranteed market for their tree products (wood, nuts, fruit, etc.) and through careful planning, companion crops (food crops, specialty crops like pine straw, green floral products, etc.) not only help them put food on the table, but also provide income for meeting other needs.

While accommodating food and income needs, agroforestry technology also creates a healthy and stimulating environment within which to raise a family. Aldo Leopold was once quoted as saying that a farm should be more than a "food factory"; it should also be "a place to live." Agroforestry, through the merging of forestry and ag-

ricultural practices, provides a basis for the family farm to be both. Through careful planning, trees and crops can be combined to yield food and income while creating the "harmonious balance" that Leopold alluded to "between plants, animals and people; between the domestic and the wild; and between utility and beauty." The addition of "working" trees and shrubs to a family farm adds beauty while retaining utility, it creates habitat for wildlife without sacrificing domestic needs, and it increases ecological diversity so that plants, animals and people are once again truly living in harmony. Agroforestry provides the opportunity to place millions of acres of idle or near-idle farm land back into production providing multiple short- and long-term benefits to the landowner and society alike. Its adoption enables us to better meet the ecological, socioeconomic and cultural needs of land management and helps us preserve a way of life that is critical to the revitalization of rural America.

Our Center's goal is to make agroforestry part of a national strategy that provides family-farm owners the opportunity to make a significant contribution to revitalizing rural America through the adoption of practices that yield sustainable profits while preserving the integrity, stability and beauty of the farm – a place for our children and our children's children to live, grow and prosper!

– Gene Garrett, Director,
University of Missouri Center for Agroforestry

THE FIVE PRACTICES OF AGROFORESTRY

ALLEY CROPPING

Alley cropping is planting rows of trees at wide spacings with a companion crop grown in the alleyways between the rows. Alley cropping can diversify farm income, improve crop production, and provide protection and conservation benefits to crops. Common examples of alley cropping plantings include wheat, corn, soybeans or hay planted in between rows of black walnut or pecan trees. Non-traditional or value-added crops also may be incorporated for extra income. Mixes can include sunflowers or medicinal herbs planted in between rows of nut trees alternated with nursery stock trees. Trees selected for alley cropping may include valuable hardwood species, such as nut trees, or trees desirable for wood products. Rows of trees, shrubs and/or grasses planted on the contour of a slope also will serve to reduce soil movement and can protect fragile soils.

FOREST FARMING

In forest farming, high-value specialty crops are grown under the protection of a forest canopy modified to provide the correct shade level. Crops like ginseng, shiitake mushrooms and decorative ferns are sold for medicinal, culinary and ornamental uses. Forest farming provides short-term income while high-quality trees are being grown for wood products. Turkey, deer, songbirds and other wildlife may find ideal habitat in a forest farming setting.

RIPARIAN FOREST AND UPLAND BUFFERS

Riparian forest and upland buffers are living filters comprising trees, shrubs, forbs and grasses, including native plants. They enhance filtration of nutrients from surface run-off and shallow ground water. These excess nutrients are utilized for plant growth. Riparian forest and upland buffers protect the water quality of streams and lakes and are an effective tool for controlling erosion and providing food and cover for wildlife. Decorative woody florals, like red osier dogwood and curly willow, and berries planted in the shrub zone provide additional income from riparian forest and upland buffers.

SILVOPASTURE

Silvopasture is the intentional combination of trees, forage and livestock managed as a single integrated practice. In a typical silvopasture practice, perennial grasses and/or grass-legume mixes are planted between rows of trees for livestock pasture. The trees not only provide a long-term investment with nut crops or a timber harvest, but also provide the animals shade in the summer and a windbreak in the winter. In turn, the forage base provides feed for cattle and other livestock which ultimately provides livestock sales. A silvopasture practice diversifies farm income; can minimize the need for chemical or mechanical vegetation control; and can reduce hay and feeding costs for livestock.

WINDBREAKS

Windbreaks are planned and managed as part of a crop and/or livestock operation to enhance production, protect livestock and control soil erosion. Field windbreaks protect a variety of wind-sensitive row, vegetable, orchard and vine crops; control wind erosion; and increase bee pollination and pesticide effectiveness. Livestock windbreaks help reduce animal stress and mortality; reduce feed consumption; and help reduce visual impacts and odors. Windbreaks also may provide excellent wildlife habitat, especially for quail and deer. These strategically placed rows of trees and shrubs also enhance production and conservation opportunities by modifying air movement and wind speeds.

UMCA RESEARCH CLUSTERS

- Nut trees
- Horticulture
- Tree/crop interactions
- Water quality and riparian forest and upland buffers
- Flood tolerance
- Fast-growing hardwood and warm-season grass bioenergy
- Forest bottomland and wildlife restoration and biodiversity
- Silvopasture/shade tolerance
- Socio/economic/marketing
- Carbon sequestration
- Technology transfer



Since 2001, the University of Missouri Center for Agroforestry has been supported by USDA-ARS grant programs. These grants fund more than 60 individual projects. The Center seeks to develop the scientific basis for designing and prescribing agroforestry practices within a “systems context,” which allows technology to be used most effectively. To achieve this goal, research efforts have been organized into 11 research “clusters” to enhance creativity and productivity among a range of investigators from many disciplines. UMCA research continues to serve as a catalyst for stimulating the development of agroforestry throughout the United States and Canada.

UMCA RESEARCH CLUSTERS

Nut trees Features research on northern pecan, eastern black walnut and Chinese chestnut, including field studies, market and consumer research and outreach. UMCA supports the nation's most comprehensive research programs for developing the eastern black walnut and the Chinese chestnut as nut crops for agroforestry practices.

Horticulture Ongoing studies include those on gourmet mushrooms, redcedar phytochemicals, elderberry, pine straw and the Missouri Gravel Bed.

Tree/crop interactions This cluster impacts all biophysical research clusters, with a focus on multiple above- and below-ground interactions between trees and crops, and also includes insect predator/prey dynamics.

Water quality and riparian forest and upland buffers The focus is to quantify environmental benefits of woody/grass buffers on non-point source pollutants. Includes paired upland watershed study, an animal bioremediation study and work on riparian forest buffers in collaboration with Iowa State University scientists.

Flood tolerance A state-of-the-art flood tolerance research facility at the Horticulture and Agroforestry Research Center is used to study the effects of short- and long-term flooding on trees and plants. Results link directly to “green infrastructure” projects in Kansas City with the Mid-America Regional Council and National Agroforestry Center.

Fast-growing hardwood and warm-season grass bioenergy The focus is to quantify growth of Populus clones, sweet sorghum, willow, switchgrass and other species for biomass production. Future studies will feature replicated trials from Columbia, Mo., to Booneville, Ark.

Forest bottomland and wildlife restoration and biodiversity Studies look at bottomland hardwood restoration and management, quantifying effects of bottomland agroforestry practices on wildlife species. Research also includes minimizing rabbit damage and enhancing mourning dove harvest opportunities in alley cropping practices.

Silvopasture/shade tolerance Studies include response of cattle and trees in pastures with planted trees; extending the grazing season with early- and late-season forages sown under alley-cropped pine; effects of managed hardwood forest stands and grazing upon understory shade tolerant forages and stand regeneration; and establishment of drought tolerant shortleaf pine and warm-season grasses on south-facing slopes in the Ozarks.

Socio/economic/marketing The cluster's integrated approach responds to the need to facilitate adoption of new practices in agroforestry, which requires understanding of the social and economic dimensions of a given enterprise. These dimensions include institutions, networks, markets, technology and environment. Research activities provide an understanding of important factors that facilitate or constrain involvement in agroforestry and are directly linked with the technology transfer program.

Carbon sequestration This cluster includes above- and below-ground carbon balance studies.

Technology transfer Efforts are centered around four outlying university research properties, with a focus on ongoing agroforestry research and landowner demonstrations in adjacent locations complemented by socio/economic/marketing studies.



A TEAM EFFORT

The University of Missouri Center for Agroforestry partners with universities, natural resource entities, agricultural organizations and landowners across the Midwest and the nation to preserve and strengthen the family farm and the nation's diverse landscapes.

MU Collaborations

University of Missouri Extension

College of Agriculture, Food and Natural Resources Partnerships with faculty in 11 departments: Animal Sciences; Horticulture; Forestry; Agricultural Economics; Rural Sociology; Entomology; Agronomy; Plant Pathology; Fisheries and Wildlife; Parks, Recreation and Tourism; and Soil, Environmental and Atmospheric Sciences.

University of Missouri National Center for Soybean Biotechnology

University of Missouri Agricultural Experiment Station Outlying Properties Horticulture and Agroforestry Research Center, New Franklin, Mo.; Wurdack Farm, Cook Station, Mo.; The Southwest Center, Mt. Vernon, Mo.; Greenley Memorial Research Center, Novelty, Mo.; South Farms, Columbia, Mo.; Delta Research Center, Portageville, Mo.; Bradford Research and Extension Center, Columbia, Mo.; and Thompson Farm, Spickard, Mo.

External University Partnerships

The Agroecology Issue Team, Iowa State University
Chetopa Experiment Station, Kansas State University

Federal and State Agency Partnerships

Federal Collaborations

USDA Agricultural Research Service - Dale Bumpers Small Farms Research Center, Booneville, Ark.

USDA Forest Service - Central Hardwoods Research Unit, Columbia, Mo.

National Agroforestry Center, Lincoln, Neb.

USDA Natural Resource Conservation Service

USDA Agricultural Research Service - Cropping Systems and Water Quality Research, Columbia, Mo.

USDA Forest Service - Hardwood Tree Improvement and Regeneration Center, West Lafayette, Ind.

State Collaborations

Missouri Department of Conservation

Missouri Department of Natural Resources

Missouri Department of Agriculture

Special recognition is extended to the Dale Bumpers Small Farms Research Center, Booneville, Ark., whose financial, scientific and collegial support have provided the impetus for the advancement of agroforestry to aid the family farm.

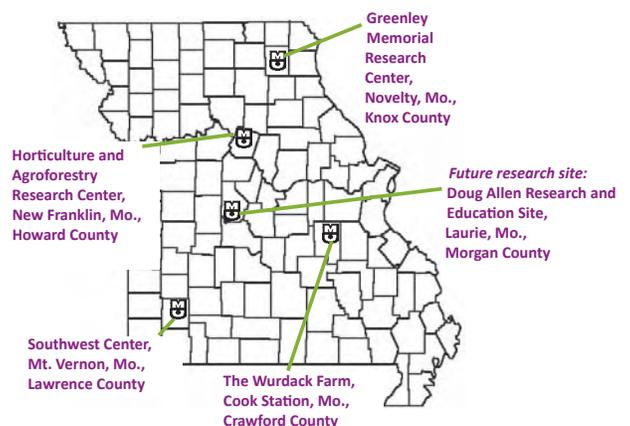
Missouri Natural Resources Conservation Service
Missouri RC & Ds

Professional Associations and Businesses

Association for Temperate Agroforestry
Forrest Keeling Nursery
Hammons Products Company
Missouri Northern Pecan Growers, LLC
Missouri Forest Products Association
Missouri Nut Growers Association
Missouri Walnut Council
Chestnut Growers of America
Missouri Farm Bureau
Missouri Farmers Union
Missouri Tree Farm Association
Missouri Christmas Tree Producers Association
Missouri Consulting Foresters Association

Donors and Friends

Doug Allen Friend of the Center; has made a planned gift of 535 acres and corresponding resources for the establishment of the Doug Allen Research and Education Site, Laurie, Mo.



The Center for Agroforestry conducts primary research on four farm sites that are part of the University of Missouri Agricultural Experiment Station, representing the economic and ecological diversity of the state. Additional research farm sites are incorporated on a regular basis as the Center expands the depth and breadth of its program.

PARTNERSHIPS, STAFF & COLLABORATORS

Leading the nation

Gene Garrett, director, UMCA, is serving on the Global Coordinating Committee for the Second World Congress on Agroforestry, late summer 2009, Nairobi, Kenya.

Mike Gold, associate director, UMCA, has served as President of the Chestnut Growers of America for 2007-2009.

Mark Coggeshall, UMCA tree improvement specialist, has completed his Ph.D. Congratulations Mark!

The Center for Agroforestry hosted the 2009 North American Agroforestry Conference, early summer 2009.

In 2008, Nature; the Journal of Soil and Water Conservation; and HortTechnology included UMCA research as highlighted articles.

In 2008, Green Horizons, a newsletter jointly produced by the Center for Agroforestry and MU Forestry Extension, was nominated for an Arbor Day Foundation media award.

During 2008, UMCA researchers and collaborators published 80 articles in scientific journals and the popular press.

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**Bruce Wight, B.S., C.F., NRCS National
Forester**



The Horticulture and Agroforestry Research Center, a 660-acre farm, is the primary research site for the MU Center for Agroforestry. The farm includes experimental fruit and nut orchards; forest farming, upland buffer and silvopasture demonstrations; greenhouses; shade and flood tolerance laboratories; and five lakes and ponds. HARC is one of the University of Missouri's 16 outlying research farms, a network of sites across the state hosting programs that bring Missouri farm and forest landowners new information for reaching maximum income potential and environmental benefits on a variety of land types and ecoregions. The farm opened in 1953 with a focus on horticultural research. In 1993, the agroforestry research program was introduced; the Horticulture Research Center officially became the Horticulture and Agroforestry Research Center in 1995. Visitors to the research farm often comment on the beautiful hills and exceptional views. The farm is positioned amidst the rich loess soils of the Missouri River Hills at one of the highest elevations in Howard County, creating a diversity of establishment sites for researching plant and tree combinations.

1819 HICKMAN HOUSE



The Horticulture and Agroforestry Research Center (HARC) is

the site of one of the state's oldest intact brick houses, the Thomas Hickman House, built in 1819. Thanks to funding from the Missouri Department of Economic Development through a Community Development Block Grant

for the City of New Franklin; federal funds secured by U.S. Sen. Kit Bond; a Save America's Treasures grant from the National Park Service; and a match from a private donor presented by the MU College of Agriculture, Food and Natural Resources, the 1,800-square-foot home is nearly complete with a rehabilitation to bring it to its historic condition.

The Hickman House represents an outstanding example of the southern

"Georgian" cottage design, a distinctive architectural style that hallmarks the early development of the Boonslick region of Missouri. The home rests just two miles from Old Franklin – the site where William Becknell and his party began the legendary Santa Fe Trail in 1821. The house was designated to the National Register of Historic Places in July 2006.

Rehabilitation efforts have included pouring a new foundation; restoring original window size and replacing panes and sashes; reshingling the roof in period materials; removing paint from and stabilizing exterior brick; refinishing original floors and woodwork; and restoring interior plaster. In addition, the four chimneys have been rebuilt from a state of disrepair and a summer kitchen has been reconstructed based on archeological and historical information.

HARC: LEADING THE NATION IN AGROFORESTRY RESEARCH

More than \$3 million has been invested in equipment and facilities at the Horticulture and Agroforestry Research Center (HARC) to create the nation's most comprehensive agroforestry research facility.

The Center funds five full-time research specialists to support ongoing research efforts on more than 400 acres of land at HARC.

Every year, workshops, trainings and outreach events bring thousands of landowners, policy makers and natural resource professionals to tour the farm's demonstration areas.

Site of extensive bioremediation, non-point source pollution and flood tolerance studies, including an innovative, outdoor 24-channel flood tolerance research laboratory.

Projects for producing gourmet, high-value mushrooms, including truffle, morel and shiitake.

U.S. National Arboretum Midwest Plant Research and Education Test Site.

Long-term research programs on the development of eastern black walnut, northern pecan and Chinese chestnut into profitable orchard crops.

SELECTED HARC RESEARCH PROJECTS

The University of Missouri Center for Agroforestry promotes a remarkable diversity of research at the farm to explore tree, grass, crop and livestock combinations optimal for establishing demonstrations of the five agroforestry practices – alley cropping, silvopasture, forest farming, windbreaks and riparian forest buffers. HARC research includes:

Agroforestry and Grass Buffers to Improve Water Quality Landowners often look to the U.S. Department of Agriculture-Natural Resources Conservation Service for assistance in selecting conservation practices to qualify for cost-share support and to meet price support payments. To assist NRCS and other natural resource-based agencies, the Center has developed a paired watershed study at HARC to measure the effects of tree and grass buffers for reducing non-point source pollution from grazing. The study also will provide data for calibrating a GIS model simulating the conservation benefits of agroforestry, upland buffer systems.

Cottonwood Clonal Trial/Flood Tolerance Evaluation Eastern Cottonwood (*Populus deltoides*) is a fast-growing, “soft” hardwood tree used to produce biomass. In 1997, cottonwood clonal trial studies began at the research farm to evaluate cultivars for their growth response and adaptability to Missouri conditions, allowing researchers to identify the best cottonwood cultivars for agroforestry plantings.

Cottonwood can be grown as a source of biomass for carbon sequestration, fuel and energy production, and levee protection, due to its suitability for floodprone areas. In 2004, a follow-up study was conducted to evaluate survival and growth of the 10 most productive cottonwood clones grown under four different flooding regimes.

Pitch x Loblolly Pine and Black Walnut Winter Forage Alley Cropping Study

This research explores the effects of row spacing on tree growth and tree/forage interactions in an alley cropping practice. Pitch pine/loblolly pine hybrids and black walnut planted in single, double and triple rows are grown to examine the effects of row configuration on these species, emulating an alley cropping practice.

Silvopastoral Systems Through well-managed grazing areas on the farm, researchers are investigating the similarities and differences in cattle performance between traditional open grazing and a silvopastoral system (combining 75 percent open pasture and 25 percent silvopasture) grazing practices. Research utilizing the pine/black walnut alley cropping demonstration area for controlled grazing is examining the success of electric fences as deterrents to protect young trees from grazing damage; how grazing and forage production affect tree growth; and how trees affect forage growth, animal health, reproduction, weight gain and beef quality.

Forage Shade Tolerance Study Throwing trees into the mix makes laboratory management of correct shade levels critical in a successful agroforestry practice. In 1994, researchers began a shade tolerance project by examining 27 forage species (native and exotic legumes, warm-season and cool-season grasses) for the effect of shade on dry weight production and nutritional value. In subsequent years, additional species have been studied. In 2005, the Shade Tolerance Laboratory was completely rebuilt and expanded to 15 structures. All species are currently being evaluated under five shade level treatments: full sun, covered with 30 percent, 55 percent or 80 percent shade cloth (70, 45 or 20 percent of full sunlight) or (cont. pg. 10)

NUT TREE IMPROVEMENT PROGRAM HAS BIG RETURNS

HARC’s nut tree improvement program focuses on identifying and testing selections of black walnut (*Juglans nigra*), pecan (*Carya illinoensis*) and Chinese chestnut (*Castanea mollissima*) for inclusion in agroforestry plantings and orchards. Major components of this research include (1) evaluating a wide array of nut cultivars on various sites in Missouri and adjoining states; (2) identifying superior rootstocks for grafting; (3) refining orchard management practices; and (4) initiating screening and breeding program(s) to develop improved selections.

Most black walnuts in Missouri are harvested by hand as they drop from wild trees in a forested setting. In contrast, the Center is working to promote black walnut as a profitable orchard crop, developing new cultivars that produce consistent yields, a consumer-preferred flavor and predictable harvest dates – allowing landowners to achieve higher yields and profits. Since the establishment of the cultivar repository in 1996, 70 black walnut nut cultivars have been acquired and placed in a series of grafted orchard collections. Beginning in 2000, a list of careful observations (“descriptors”) was initiated on an annual basis for all of the cultivars. This information allows researchers to learn more about how a species can vary for a number of commercially important characteristics (e.g., yield). In 2007, researchers authored a popular guide for landowners, “Growing Black Walnut for Nut Production.”

Chestnut is a crop largely unknown to Americans since the near extinction of the American chestnut forests from chestnut blight in the first half of the 1900s. The Chinese chestnut shows excellent potential for Missouri/Midwestern landowners as a cash income crop. Currently, wholesale and retail prices are high, and demand exceeds supply for this sweet, starchy, nutritious nut. Chinese chestnut cultivar research at the HARC farm began in 1996. The research repository includes more than 60 cultivars under evaluation in an orchard setting to determine the best-suited selections for Missouri’s promising chestnut industry.

HARC/SW CENTER RESEARCH

a “sunfleck” treatment. Research emphasis has recently switched from cool-season to warm-season forages, including big and little bluestem. Forages tested in the Shade Tolerance Laboratory are subsequently field tested under tree canopies.

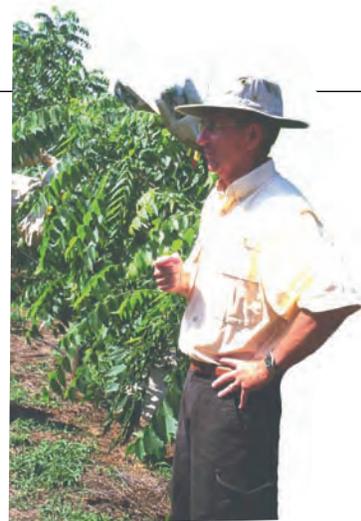
In 2008, the sunfleck treatment was changed from small flecks to larger blocks of sun and shade to more realistically mimic a forested environment as the sun passes in its arc across the shade tolerance laboratory.

In the future, UMCA researchers hope that identifying physiological factors associated with plants’ shade tolerance will aid in finding shade tolerance species based solely on the plants’ characteristics, to augment lab and field testing.

Flood Tolerance Laboratory The laboratory lays adjacent to Sulphur Creek in the Missouri River floodplain and is one of the nation’s most comprehensive and unique field laboratories for studying the response of plant species to the periodic flooding common to Midwestern floodplains. Selected grasses, legumes, soybeans, sweet sorghum and tree species are being evaluated for flood tolerance. The flood tolerance of hardwood planting stock and genetic variation in ecotypes from seed collection from bottomland and upland stands also is being studied.

Pine Straw The purpose of this study is to evaluate pitch x loblolly hybrid pines (*Pinus rigida x taeda*) and cold hardy pure loblolly pines (*P. taeda*) for their suitability for the production of pine straw mulch

in Missouri. Pine straw, the naturally shed needles of pine trees, is an excellent mulch material used extensively in the southeastern United States in landscape plantings. The purpose of hybridizing these two pine species was to create a pine with the cold hardiness of a pitch pine and the fast growth rate and long needles of a loblolly. Fifteen different genotypes of this hybrid are being evaluated for cold hardiness, growth rate, needle length and needle yield.



In addition to research underway at the Horticulture and Agroforestry Research Center, UMCA’s specialty crop studies extend to the University of Missouri’s Southwest Center, Mt. Vernon, Mo. Studies vary from elderberry to pawpaw, persimmon, black cohosh and chinkapin, in addition to extensive research on black walnut, pecan and Chinese chestnut trees. These specialty crops are of interest to Missouri producers and may have potential within a variety of agroforestry systems.

SELECTED SOUTHWEST CENTER RESEARCH PROJECTS

Elderberry Numerous American elderberry (*Sambucus canadensis*) experiments, replicated at Mt. Vernon, Mountain Grove, (and some also at Corvallis, Ore.,) are now completed and are in various stages of publication. In 2009, two new locally selected elderberry cultivars from this program will be released.

Researchers continue to evaluate more than 60 elderberry selections. In 2008, a new four-year, second-generation elderberry cultivar evaluation was planted at Mt. Vernon, Mountain Grove, and at Lincoln University, Jefferson City, Mo.

Persimmon The persimmon orchard at the Southwest Center was expanded to its full size of 98 trees in 2008; one of the largest American persimmon research orchards in the country. Most of the trees are being established with seedling rootstocks of known improved cultivars; the orchard has 27 improved persimmon cultivars established for evaluation. A grafted cultivar evaluation experiment, with 10 cultivars, was initiated in 2008 in concert with plantings at the Missouri State Fruit Experiment Station in Mountain Grove, Mo.

A RIPENING FIELD Persimmons are generally light yellow-orange to dark red-orange in color, and may be spherical, acorn-, or pumpkin-shaped. They should only be eaten when ripe and soft or they may have an astringent taste.

Ozark Chinkapin Ozark chinkapin (*Castanea pumila* var. *ozarkensis*) is a threatened tree native to southwest Missouri that has been devastated by chestnut blight. The species once had commercial value for lumber and nuts, and was important to wildlife, livestock and humans. A 2006 grant from the Northern Nut Growers Association allowed establishment of three southwest Missouri research orchards (including one at the Southwest Center); however, the seedling chinkapin trees have not performed well. In 2008, researchers grafted chinkapin onto Chinese chestnut rootstocks to evaluate different types of grafts and the compatibility of Chinese chestnut as a rootstock for Ozark chinkapin.

MISSOURI CHESTNUT ROAST

The Missouri Chestnut Roast, hosted annually by the University of Missouri Center for Agroforestry, serves as a showcase for Missouri specialty agricultural products. As a fall harvest festival, it celebrates Missouri's bounty above and beyond traditional crops like corn, soybeans, rice and wheat.

Vendors showcase their spreads, from fresh goat cheese, gooey pecan candies, diverse Missouri wines and zesty regional beer, immune-boosting elderberry extract, to fresh chestnuts, roasted – of course – over an open fire.

Missouri's bounty can be mouth watering – and scenic at the same time!

“Specialty crop production is a great fit for many Missouri landowners,” said Michael Gold, associate director of the Center for Agroforestry and research professor of forestry. “Diversified farm income, new market opportunities, sustainable agriculture, land stewardship and habitat for wildlife are just a few of the benefits agroforestry can bring to your land.”

The sixth-annual Missouri Chestnut Roast, held Saturday, Oct. 18, 2008, celebrated the chestnut, pecan and black walnut harvest at the MU Horticulture and Agroforestry Research Center, and was a great reason to invite Missouri's other local specialty crop vendors over for the day.

In addition to product samples and sales, the Roast offered sales of native plants, nut trees and elderberries, as well as expert presentations on elderberry production, regional cuisines and heritage tourism and Missouri's local foods.

“Local is an important new trend,” Gold said. “Eating locally produced foods and enjoying a regional ‘sense of place’ like the lovely Missouri River Hills region has piqued the interest of people in Missouri and across the country. Missouri ‘agritourism’ has so much to offer in this arena, and we love to show it off through the Roast. Eating local is good for the environment, the economy and your palate, of course!”

THE HIGHLIGHTS: ROAST 08

Event set in beautiful Missouri River Hills

Tours of historic 1819 Hickman House, in final stages of historic rehabilitation

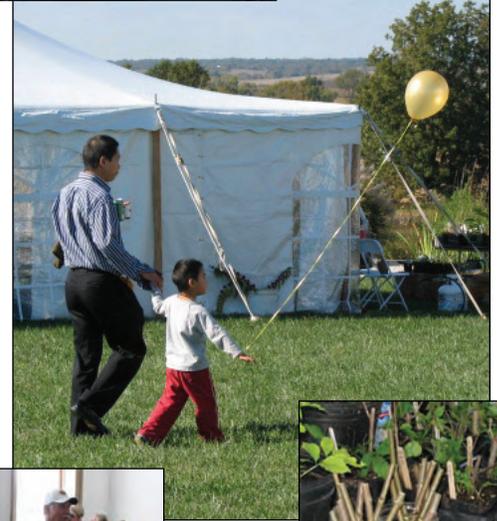
Showcase of Missouri's niche agricultural products, including wines; jams and jellies; nut products; honey; cheeses and meats

Demonstrations for cooking with chestnuts, and chance to buy chestnut trees and nuts; sample roasted and braised chestnuts; and see chestnut trees growing in Missouri

Guided walking and bus farm tours

Live bluegrass and Caribbean/Spanish guitar music

Children's activities including straw bale maze, live bat presentation, fact hunt, balloons and nutty ice cream



TECHNOLOGY TRANSFER

Among the primary goals of the Center for Agroforestry are to educate and inform landowners and natural resource professionals about new research in agroforestry, and to demonstrate how this research can be successfully applied to their operations. The UMCA Technology Transfer team takes these goals to heart, working to bring knowledge of the practices of agroforestry and the Center's ongoing research to landowners, forest and farm organizations, natural resource professionals and extension agents from across the state and the Midwest through on-site consultations, educational workshops, publications, newsletters and informational exhibits.

PROMOTING AGROFORESTRY

In 2008, the UMCA Technology Transfer team participated in more than 30 agricultural and natural resources-related conferences and events, serving as featured speakers at many events. From the National Small Farms Trade Show to the Annual Walnut Council Meeting, and the Missouri Dietetics Association Conference to the Downtown Columbia Living Windows Festival, the team reached thousands of land and forest owners and consumers with new research findings and information on the benefits of agroforestry and specialty crops.

2008 UMCA EVENTS

January	UMCA Annual Research Review, Columbia, Mo.
February	Missouri Nutgrowers Annual Meeting, Nevada, Mo.
March	Workshop for Natural Resource Professionals, Wilmar, Minn.
June	Workshop for Natural Resource Professionals, Lanesboro, Minn. Agroforestry Training for Professionals and Landowners, Fairfield, Iowa
October	Joint Meeting of the Missouri and Iowa Nut Growers Association, HARC 6th Annual Missouri Chestnut Roast, HARC (see pg. 11)
November	Agroforestry Training for Professionals and Landowners, Hardin, Ill.
December	Benefits of Windbreaks in Agroforestry Workshop, Neosho, Mo.



The Center for Agroforestry sets up exhibit booths at numerous conferences and events throughout the year. Each exhibit is tailored to the particular event and audience, and can include an informational poster, copies of Center publications and chestnut and other agricultural specialty product examples. UMCA staff roasted chestnuts at three mid-Missouri events in fall 2008, introducing hundreds of consumers to the taste of the sweet, starchy nut.

Agroforestry Trainings for Professionals and Landowners

In 2008, the Center for Agroforestry hosted two general agroforestry trainings for professionals and landowners, in Hardin, Ill., and Fairfield, Iowa. Surveys were conducted to determine attendees' perceptions of the events. The workshops were targeted to landowners, natural resource professionals, members of government agencies and members of professional and non-profit organizations working with land management issues. Attendees said they were very satisfied with the training; they gained a significant amount of knowledge for all topics presented and their perception of agroforestry was enhanced. The Hardin, Ill., workshop included comprehensive presentations on agroforestry practices, biomass for energy production and conservation, silvopasture, gourmet mushroom production, nut production and marketing and specialty wood products. In Fairfield, Iowa, the focus was on the latest science in support of agroforestry practices, windbreaks, riparian forest buffers, silvopasture, agroforestry adoption, benefits of agroforestry practices for wildlife and information intended to assist landowners in marketing the products they grow.

In addition, a 2008 training workshop focused on windbreaks: reducing energy use and helping control odor. This session was held in Neosho, Mo., and talks focused around windbreak design, planting and irrigation; programs supporting windbreak creation; and identifying and controlling odor from livestock. Attendees also were taken on a field tour to view a local windbreak.

PUBLIC, MEDIA RELATIONS

Keeping landowners, the public, the media, natural resources professionals and decision makers up-to-date with the University of Missouri Center for Agroforestry's achievements is an important task. Tools for accomplishing these goals include informational guides and brochures; newsletters; news releases, both print and video; media contacts; advertising; radio and television appearances; and the Web site. In 2008, large-scale promotional efforts focused on both the 6th annual Missouri Chestnut Roast event and the 11th North American Agroforestry Conference, hosted by the MU Center for Agroforestry (May 31-June 3, 2009).

Articles about the Center for Agroforestry appeared in the AAA Midwest Traveler in the March/April 2008 issue; in Rural Missouri magazine in June; and in the High Plains/Midwest Ag Journal in April. In addition, many news stories about the Missouri Chestnut Roast could be found in area media in October, including radio reports and interviews, articles in the Columbia Daily Tribune and the MU Maneater, and an event notice in the St. Louis Post-Dispatch, for example. In addition, the Roast and chestnuts were featured on KOMU TV-8's "Pepper and Friends" local television program with a chestnut cooking demonstration.

Informational Guides

In 2008, UMCA created a unique guide outlining how best to integrate agroforestry to encourage wildlife, along with other benefits – "Integrating Agroforestry Practices for Wildlife Habitat." The guide is part of the Center's line of "Agroforestry in Action" publications, which help landowners implement practices with step-by-step instructions. In addition, in 2008 the guide "Growing Shiitake Mushrooms in an Agroforestry Practice" was given a major update based on recent UMCA research findings.

Along with guides for landowners, UMCA creates informational pamphlets for consumers of niche agricultural products grown in agroforestry practices, including guides on the nutritional benefits of chestnut, black walnut and pecan. In 2008, the nutritional guides "Why Pecan?" and "Why Black Walnut?" were updated and reprinted. New in '08 was a "Chestnut Roasting 101" guide sheet for event coordinators and general consumers.

Finally, a guide was created for navigating the Center's Missouri Exchange Web site, an online marketplace for buyers and sellers of Missouri agricultural products (www.missouriexchange.com).

Newsletters

UMCA Technology Transfer reaches out to landowners in one of the most direct ways possible – newsletters. Green Horizons, a quarterly Center for Agroforestry publication, provides readers with information about forestry- and agroforestry-related topics. In 2008, Green Horizons was nominated for an Arbor Day Foundation media award. The Chestnut Grower, the official newsletter of the Chestnut Growers of America, is the pulse of the chestnut industry in the U.S. and also is published quarterly.

ALLEN FARM EFFORTS

The 535-acre Doug Allen Research and Education Site plays an increasingly important role in the Center for Agroforestry and School of Natural Resources, serving to demonstrate land use practices that work in concert with the environment and are economically viable. Further, in the coming years the property will serve as an educational environment that offers learning and research opportunities for a multitude of natural resource disciplines. Under the direction of MU Forestry Professor John Dwyer, students have developed a working inventory and management plan for the 422 forested acres, and renewed efforts to enhance the integration of crops, warm-season grasses and riparian buffer shrubs to the benefit of a specific wildlife species – bobwhite quail. In 2008, approximately 22 acres of warm-season grasses and forbs were established.



UMCA Roasting Chestnuts on an open fire at the Living Windows Festival in downtown Columbia, Dec. 5, 2008.

Pawpaw: The ‘tropical’ native fruit



It's hard to believe a fruit with the flavor of the tropics could be native to Missouri. But it's true. And the MU Center for Agroforestry is working to get the word out about the pawpaw.

“People are pretty surprised that this exists here,” said Michael Gold, associate director of the Center and research professor of forestry. “That’s the fun thing about introducing people to it.”

Pawpaw is an oval-shaped fruit indigenous to the eastern U.S., and is green when unripe, maturing to yellow or brown. Its flesh is peachy-colored, creamy, custard-like, and tastes like a cross between a banana, mango and pineapple. Taste-wise and botanically, it is related to tropical fruits; pawpaw is in the mostly tropical custard apple family, *Annonaceae*. In its native habitat, the pawpaw tree grows in clumps in deep, wet soils as an understory tree.

The pawpaw is eaten fresh (avoiding the numerous large black seeds) or processed into desserts and baked goods – it’s a great texture and flavor for adding to smoothies, ice cream and yogurt, for example. Pawpaws are higher in protein than most fruits, and are a good source of calcium and Vitamin C.

The University of Missouri Center for Agroforestry is partnered with a group of universities and other organizations to try to shift pawpaw from the wild to a cultivated orchard crop, Gold said. The Center’s Research Scientist, Ken Hunt, planted one acre composed of 10 cultivars at UMCA’s Horticulture and Agroforestry Research Center in 1999. He is looking to see which pawpaw cultivars are best for Missouri, in terms of size, taste, yield, etc. Cultivars are grown in orchards in full sun and produce a much heavier fruit set and larger fruits than in the wild.

Hunt, Gold and others took the Center for Agroforestry’s harvest (the first sizeable one since planting) to the Columbia Farmers’ Market in September 2008 to test the public’s response to the fruit.

“We had a great reception,” Gold said. At \$1 apiece, the 200 pawpaws they brought along were sold out in a couple of hours. Samples were available to familiarize buyers with the unique taste. An after-purchase survey showed although 93 percent had never purchased a pawpaw before, 97 percent liked it, 93 percent would buy again, and the same percentage would recommend it to a friend.

Although the pawpaw is a healthy fresh fruit choice and has a distinct, tropical flavor (right here in the Midwest!) there is a slight “catch.” The fruit is highly perishable (keeps only a couple of days after harvest and just slightly longer in the fridge – where its flavor can even be altered) and does not ship well, in addition to the storage issues. Pawpaw harvest lasts for a few weeks between August and October, depending on the cultivar.

WHAT'S OLD IS NEW AGAIN

Although few people have tried pawpaw, the fruit has a long history in the eastern United States. Lewis and Clark noted their men were “very fond of” the “Pappaws” or “custard apples” of which “this country abounds.”

Although the perishability of pawpaw has long counted them out as prime candidates for heavy cultivation, Gold and others feel pawpaw could have a future as an orchard crop. They are native, have few pests (easy to grow organically), are fairly low maintenance and are a beautiful tree; in addition, the perishability can be addressed by freezing pawpaw pulp (Gold sees this as a larger market potential than fresh fruit).

“Our goal is to bring pawpaw on as another new alternative crop for landowners,” Gold said. “Right now we’re sort of ‘dipping our toe in the water’ to see if the market is receptive. Stay tuned!”

The UMCA socio/economic/marketing (SEM) cluster looks at human and economic dimensions of agroforestry including individual attitudes, knowledge, incentives and social-economic-resource characteristics; role of institutions in constraining or facilitating agroforestry; knowledge of markets for new products; role of agroforestry in agritourism; and networks that facilitate access to information about agroforestry practices. Current research looks at the barriers that keep people from adopting agroforestry practices, chestnut preferences and motivations for attending the annual Missouri Chestnut Roast. In addition, an elderberry market research study was launched in December 2008, with results to follow. The cluster also created and administers the Missouri Exchange Web site, an online marketplace for buyers and sellers of Missouri agricultural products. See the interactive site at www.missouriexchange.com



AGROFORESTRY AND RECREATION

In 2008, UMCA SEM research identified two landowner groups according to the recreational services they provided: Farming Lifestyles Landowners (FLL) and Rural Lifestyle Landowners (RLL). The two groups differ in their engagement in agricultural production, types and amount of recreational services provided, and socio-demographic and farming attributes.

Overall, FLL mostly offer recreational services linked to the farming lifestyle, such as fishing, hunting and horse-back riding. RLL are highly diverse, offering significantly more recreational services associated with the rural lifestyle, such as hiking and nature contemplation. (FLL are mostly full- and part-time farmers, while RLL are mainly non-farmers.)

Results also show significant differences in the understanding of most agroforestry practices and interest for their adoption between the two groups. RLL are more interested in and knowledgeable about agroforestry. Preliminary analyses show RLL have higher perceptions of their economic and non-economic values compared to the FLL and that barriers associated with low short-term profitability of agroforestry are less influential for the RLL than the FLL.

These results have important implications for the spread of agroforestry practices among landowners. Results suggest different strategies should be applied to inform landowners about the values of agroforestry.

This research will aid in UMCA's work to determine the relationship between the perceived values of agroforestry and their perceived barriers for adoption.

Source: Barbieri, C., and C. Valdivia. 2009. Recreational multifunctionality and its implications for agroforestry. Agroforestry Comes of Age: Putting Science into Practice. Proceedings, 11th North American Agroforestry Conference, Columbia, Mo., May 31-June 3. Gold, M.A., and M.M. Hall, Eds. 475-484.

ATTENDANCE MOTIVATION

In 2008, UMCA researchers surveyed more than 500 attendees at the annual Missouri Chestnut Roast to find out their motivations behind attending. In addition, the study looked at different socio-economic attributes, levels of chestnut consumption and event behavior associated with the different motivations.

The most common reasons for attending included enjoying a day out, the uniqueness of the festival, and tasting chestnuts and other Missouri agricultural products. From this, researchers found three motivation dimensions: Fun and Entertainment, Theme Identity and Educational Experience. Each dimension related to different attributes, including age, education level, number of people in the party and distance traveled to the festival.

This research shows the need to convey three types of messages in promotional efforts and planning of event offerings. Characteristics associated with these motivations need to be recognized in marketing and programming. Further analysis is underway to segment attendees based on motivations and better target current and potential customers.

Source: Barbieri, C., M. Cernusca, M. Gold, and F.X. Aguilar. 2009. Attendance motivations behind the Missouri Chestnut Roast festival. Agroforestry Comes of Age: Putting Science into Practice. Proceedings, 11th North American Agroforestry Conference, Columbia, Mo., May 31-June 3. Gold, M.A., and M.M. Hall, Eds. 505-512.

GROWING THE MARKET A UMCA study showed a relationship between consumers' frequency of chestnut consumption, familiarity with chestnuts, buying behavior and previous attendance at the annual Missouri Chestnut Roast. As expected, people who have not attended the Roast are far less likely to have purchased chestnuts. This is just another way of saying that being introduced to chestnuts at the Missouri Chestnut Roast makes people much more likely to go out and buy the versatile nut. The Roast is fun and functional!

TREE/CROP INTERACTIONS

This UMCA cluster studies the complex interactions between trees and crops inherent to agroforestry. In any system, trees and crops may compete for light, water and nutrients or have complementary needs. The goal is to successfully manage these interactions.

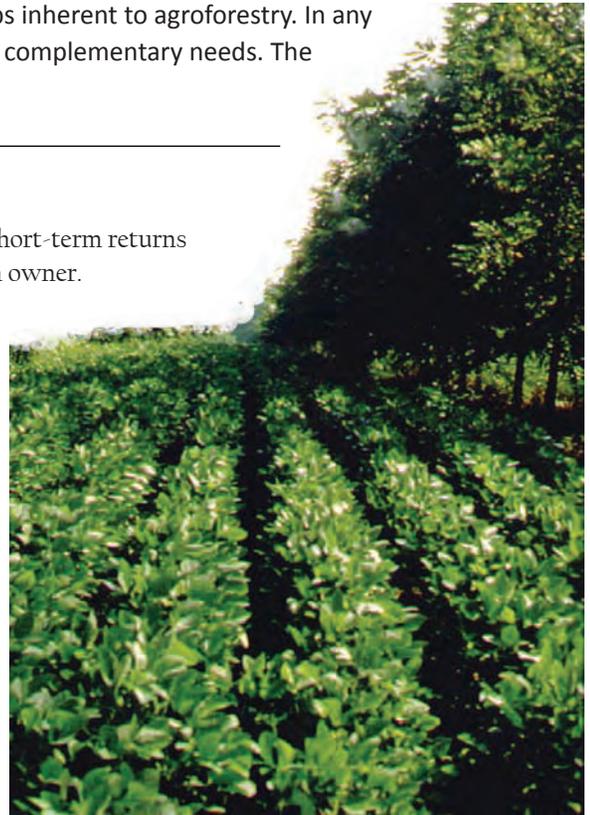
PROMOTING BENEFICIAL INSECTS

A crop management system that reduces insecticide use while providing both short-term returns (crops) and long-term profits (nuts/wood) would greatly benefit the small farm owner.

This UMCA project compared crop yields and beneficial insect populations between various alley cropped and conventional, or monoculture, agricultural systems.

Findings on alley-cropping projects using both alfalfa and canola/wheat show there are significantly more individual insects, more species and more predators in both narrow and wide tree alleys compared to the conventional monocrop. This close agreement is significant because these results indicate a common positive response by insects to the practice of alley cropping and not a response reliant on the individual crops or alley widths; alley-cropping itself is good for beneficial insect populations. Findings did, however, show a difference in yield data between narrow (-40 ft.) and wider (-80 ft.) alley widths for alfalfa, although not for wheat/canola. Alfalfa would only be economical in wider alleyways, according to UMCA researchers.

Source: McGraw, R.L., W.T. Stamps, J.H. Houx, and M.J. Limit. 2008. Yield, maturation, and forage quality of alfalfa in a black walnut alley-cropping practice. Agroforestry Systems 74: 155-161.



THROWING LEGUMES INTO THE 'MIX'

Native legumes are an important component of savanna ecosystems as they aid in providing a source of fixed atmospheric nitrogen and are an excellent food source for wildlife and livestock. The CP25 Savanna Restoration Practice in Missouri requires landowners to establish a mix of native trees, grasses and forbs, but little is known about their establishment and interaction within plant mixes. Two studies were launched to see what effect native legumes, in addition to native grasses, would have on seedling establishment. The study shows trees established well, with bur oaks growing much larger than the other trees used in the study.

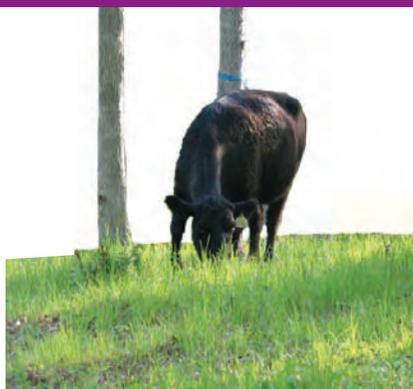
Source: Van Sambeek, J.W., N.E. Navarrete-Tindall, and K.L. Hunt. 2008. Growth and foliar nitrogen concentrations of interplanted native woody legumes and pecan. In: Jacobs, D.F., and C.H. Michler, eds. Proceedings, 16th Central Hardwood Forest Conference. Gen. Tech. Rep. NRS-P-24. Newtown Square, Pa: U.S. Department of Agriculture, Forest Service, Northern Research Station: 580-588.

PITCH X LOBLOLLY + FESCUE = SILVOPASTURE

Millions of acres of tall fescue pastures reside in Missouri. The greatest potential for increasing the adoption of silvopasture in the state is to add trees to these pastures. However, some trees do not establish easily in tall fescue. UMCA research has shown pitch x loblolly pine is one species only slightly affected by grass competition – it appears well suited for silvopasture establishment in tall fescue pastures with minimal weed control inputs.

Researchers also found that using irrigation and fertilizer to alleviate competition between trees and grasses does not appear justified – it appears factors other than moisture competition are reducing tree growth when planted into grass.

Source: Houx, J.H. III, and R.L. McGraw. 2008. How much weed control is necessary for establishment of black walnut in tall fescue pastures. Agronomy Abstracts (CD-ROM), ASA Madison, Wis. Abstract.



Silvopastoral management creates an environment where trees, forage and livestock work together and can be developed to their full economic potential. Numerous greenhouse, field and pasture studies show silvopastures can be productive complements to traditional pastures. But there is limited research on how silvopastures fit into a “system.” Converting all of a pasture system to silvopasture is unlikely on a wide scale. UMCA silvopasture research seeks to determine the feasibility of introducing silvopasture as part of a whole-farm forage/livestock system combining rotationally grazed open pasture with rotationally grazed silvopasture into an overall production system.

UPLAND HARDWOOD SILVOPASTURE

UMCA researchers are working to create a model to express the changes that occur in upland hardwood silvopasture practices. The model will project the management needed to maintain light environments conducive to maintain understory forages through manipulations of overstory and underplanted tree density levels.

FINISHING BEEF STEERS IN SILVOPASTURE

Consumers are increasingly concerned with the types and quantity of fat present in the food products they consume. This is leading to a shift in the way food is produced, in particular increasing the number of organic and “naturally finished” beef products available to consumers. In 2008, UMCA research looked at whether beef finished in a silvopasture system pro-

duced meat with a healthier fatty acid profile than animals finished on open pasture. Steers finished in silvopastures had greater average daily gains, larger ribeye areas and greater total fatty acid concentrations in their meat compared to steers finished in open pastures.

However, the differences in shade-grown forage nutrition did not translate into any differences in the specific fatty acid concentrations of meat harvested from steers.

Source: Robert Kallenbach. 2009. Integrating silvopastures into current forage-livestock systems. Agroforestry Comes of Age: Putting Science into Practice. Proceedings, 11th North American Agroforestry Conference, Columbia, Mo., May 31-June 3. Gold, M.A., and M.M. Hall, Eds. 455-461.

Use of windbreaks for odor abatement in confined animal feeding operations is recent and the behind it is limited. Variability in windbreak effectiveness is known to be related to its physical location, species composition, density and geometric configuration.

Although research is ongoing to develop a better understanding of how and why windbreaks impact odor perceptions, combinations of trees and shrubs in windbreak configurations have been

NUTS AND BOLTS The ‘odor’ break has a footprint of approximately 18 acres and consists of pitch/loblolly pine hybrid, pin oak alternated with red maple, and Allegheny Viburnum, a semi-evergreen shrub. Since effectiveness of windbreaks are associated with height and density, the largest plants available were used in establishing the windbreak. The inside pine row was positioned a minimum of 60 feet from the building, with pin oak/red maple 20 feet from the pine and viburnum 20 feet to the outside of the pin oak/maple. Spacing within the tree rows was 15 feet while shrubs were spaced at 8-foot intervals. Where necessary, a “trip row” of pine and shrubs was included to avoid potential snow build-up issues.

shown effective at changing the movement of odor particles. Trees and shrubs create a living filter that removes dust particles from the air, and many of the chemical compounds that can cause odors are attached to those particles. Additionally, windbreaks alter air currents.

UMCA researchers have constructed a three-row windbreak (see box, left) at a confined animal feeding operation facility in northcentral Missouri to test the effectiveness of plant material to diminish odor. In 2008, the third and final row of trees around the facility was established. Each row also had weed mat and irrigation lines installed in 2008.

Air sampling in a one-mile radius around the facility began in 2008, and is ongoing. Samples are taken four to six times each season at various locations: just outside the exhaust fans, between the fans and the inside row of the windbreak and at intervals of distances downwind from the windbreak.

Although results are preliminary, it appears concentrations of volatile compounds are significantly reduced over a very short distance.

NUT TREES

UMCA's nut cluster features research on pecan, black walnut and chestnut, including field studies, market and consumer research, and outreach. The Center supports the nation's most comprehensive research programs for developing the eastern black walnut and Chinese chestnut as nut crops for agroforestry practices. For new orchards to succeed, reliable cultivar information and proven orchard management techniques are essential. Field trials look at cultivar traits such as bud break, flowering, nut yield and nut weight to see which cultivars should be recommended for the Midwest and which crosses might yield the next generation of improved cultivars. Studies also include those on fertilizer, pests, grafting techniques, applied breeding and, in collaboration with the socio/economic/marketing research cluster, characteristics of a marketable nut.



CHESTNUT

Fundamental research on Chinese chestnut cultivar performance at HARC has shown that care should be taken to reduce stress on grafted trees by spring planting instead of fall planting.

Initial observations indicate that pine straw mulch also improved tree growth with less graft failure on 'Qing' trees compared to shredded hardbark mulch.

Plantings with various tree spacing and pruning techniques are being established to determine effects of pruning on nut yield, size and quality.

In 2009, five different fertilization rates of nitrogen will be evaluated at the Horticulture and Agroforestry Research Center to determine which is best for chestnut growth and yield. Current recommendations are based on yield results of hazelnuts and have led to nitrogen deficiency in HARC chestnut trees. Other chestnut research at HARC includes:

DWARFING THE POSSIBILITIES

Mature Chinese chestnut trees can grow to 45 feet, and black walnut to 125 feet at maturity, raising the costs of management practices such as pest control, pruning and harvesting. Thus, the use of dwarfing rootstocks might be a way to reduce production costs and thereby increase profitability. However, dwarfing rootstocks, in addition to tree size, also affect anchorage, disease susceptibility, precocity, and soil and climatic adaptability.

Recently, various chestnut and black walnut cultivars were identified as a potential source of genetic dwarfing. Studies are looking at the compatibility of graft unions and vegetative growth and productivity of trees to determine if dwarf rootstocks are feasible for chestnut and/or black walnut orchards.

Chestnut weevil

The scoop: Chestnut weevils are currently the single greatest threat to the commercial growth of the emerging chestnut industry. Populations tend to rapidly reach economically devastating densities and, if untreated, have the potential to destroy entire chestnut harvests. However, there are relatively few scientific publications reporting on the basic biology and ecology of chestnut weevils. Consequently, there are no effective means of monitoring the weevils' dispersal and orientation behaviors. UMCA researchers aim to establish an integrated pest management strategy for chestnut.

The study: UMCA researchers are looking to identify the major components of chestnut volatiles and evaluate weevil behavioral and physiological response to the volatiles. This will provide a comprehensive view of the chestnut weevil's relationship to its host tree. So far, in the laboratory, weevils have responded positively to odors in catkins, burs and nuts, but not leaves.

The next step: Studying the complicated volatile profile of catkins, burs and nuts to determine to which ones weevils are attracted.

Source: Keesey, I.W., and B.A. Barrett. 2008. Preliminary data on chestnut plant volatiles as attractants to the lesser chestnut weevil, Curculio sayi (Coleoptera: Curculionidae). Entomological Society of America annual meeting, Nov. 18, Reno, Nev. Poster.

PECAN

In developing commercially adapted northern pecan cultivars for Kansas and Missouri, researchers have identified "Kanza" as the premier cultivar. In addition, in conjunction with scientists at St. Louis University, researchers are performing fundamental studies characterizing traits to contribute to developing models of genetic diversity of the pecan population across its geographic range.

BLACK WALNUT

2008 was a busy year for the black walnut applied breeding program at HARC:

- Researchers created a chilling model that accurately describes the effects of winter temperatures on spring budbreak patterns in black walnut. Cultivars with a high chilling requirement are likely better suited to more northern locations, while cultivars with low chilling requirements may be better suited to southern locations. Next up is developing models that address spring pistillate male and female flowering patterns.
- Findings showed black walnut trees bearing alternately are less productive than those bearing annually.
- 7,200 open-pollinated nuts representing two popular cultivars were sown in fall 2008 to create a mapping population for future genetic studies.
- Researchers genotyped all of the trellised black walnut trees at HARC – “fingerprinting” work for all trees in the research program is scheduled for 2009-10.
- Cultivar-specific growth rates were used to determine the number of years to crown closure in orchard settings, which ultimately impacts nut yields due to shading effects.

Up next, researchers will plant the best performing control-pollinated individuals to look at, for the first time, genotype vs. environmental (GxE) effects on nut yield and other traits.

Other research includes:

Sensory and flavor characteristics

The scoop: Black walnut flavor preferences are unknown but would aid in marketing nuts.

The study: Light, medium and dark-colored kernels of three black walnut cultivars and one wild type were evaluated for 23 flavor attributes. Kernel taste attributes varied based on color and cultivar, although medium and light kernels of cultivars have the most desirable flavors when eaten as a fresh product.

The next step: Testing whether consumers prefer stronger or milder kernels.

Source: Warmund, M.R., J. Elmore, M.A. Drake, and M.D. Yates. 2009. Descriptive analysis of kernels of selected black and Persian walnut cultivars. Journal of the Science of Food and Agriculture 89(1): 117-121.

INTERACTIVE CULTIVAR COMPARISON COMES TO YOUR COMPUTER

Comparison shopping is easy when you can put two choices side-by-side and weigh the pros and cons of each. With this in mind, Drs. Mark Coggeshall, UMCA tree improvement specialist, and Michele Warmund, MU professor of horticulture, created the online tool, “Flowering and Fruit Characteristics of Black Walnuts: A Tool for Identifying and Selecting Cultivars.”

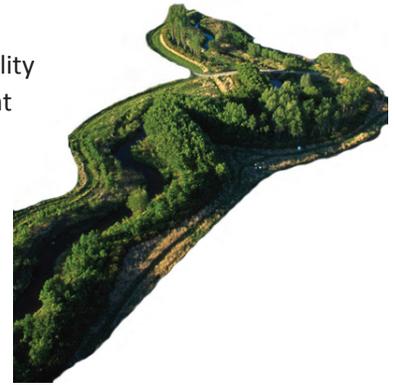
This Web site is intended to help walnut growers identify walnut cultivars by the appearance of the husk, shell and kernel and to select cultivars on the basis of various growth characteristics. In addition to a photo gallery of black walnuts, the publication lists the average date of budbreak, flower type, bloom period, pollination date, season length and harvest date for more than 40 black walnut cultivars. Data were collected over a four-year period from 2002 to 2006 at New Franklin, Mo.; dates reflect the growing season in central Missouri and should be adjusted for other regions.

Next up, nut yield and crown spread data will be added for each cultivar.

See this tool at <http://extension.missouri.edu/explore/miscpubs/xm1001.htm>

RIPARIAN FOREST AND UPLAND BUFFERS

Riparian forest and upland buffers are an important agroforestry practice that protects water quality by slowing surface runoff, improving infiltration, reducing sediment transport, removing non-point source pollutants, stabilizing streambanks, increasing diverse food and cover for upland wildlife, improving aquatic habitats for fish and other organisms and enhancing opportunities to generate farm income through products harvested from the buffer. The Iowa State University Agroecology Issue Team has been working closely with the University of Missouri Center for Agroforestry for the past 10 years to evaluate the performance of riparian forest buffers and develop management plans to maintain the benefits of the buffer over time. While many buffers have been planted over the past two decades, little research has been conducted on their efficacy over time or on the long-term management needed to maintain their continued functionality.



ISU BUFFER RESEARCH

The goal of much of the UMCA-supported work of Iowa State University scientists in northeast Missouri is to determine if the density of present “natural” forest buffers or constructed buffer ground cover is sufficient to slow and diffuse concentrated flow and/or if grass filters upslope of the narrow riparian forest buffers are necessary to aid in providing that function.

IT TAKES 3 Three different sources contribute sediment to streams: surface runoff, bank erosion and sediment resuspension.

presence of ground cover, can punch surface runoff and pollutants through forest buffers to streams. Researchers suggest creating (or managing) forest buffers with less tree density (more light penetration) and more ground cover to better filter surface runoff. The grass filter used, however, must be of the correct species and width; findings show that cool-season grass filters, for example, may not be wide enough to handle the sediment load delivered by gullies. This work is providing data to support the development of an assessment tool that will allow conservation professionals to quickly identify potential sites that could benefit from a grass filter planting and/or timber stand improvement of an existing forest buffer.

Stream Bank Stability Another aspect of the work of the ISU team is to quantify the extent of stream bank erosion and compare that to sediment originating from surface runoff and to determine the role and impact of perennial plant community root systems in maintaining bank stability. This work could result in a set of unique design recommendations for stream bank edges in riparian buffers and filters.

Gullies In 2008, Iowa State researchers found that warm-season grass filters aid in diminishing gullies, which, without the

LAND USE MATTERS Iowa State studies on land uses and effects on bank stability (and therefore sediment production) show that streams with riparian forest buffers reduce the length of eroding stream bank from around 40 percent for row cropped and intensively grazed areas to less than 15 percent, well within the limits of about 20 percent found in healthy streams. This translates to a seven- to nine-fold reduction in both sediment and phosphorus contribution to the stream channel from properly buffered streams. Results also show livestock access points and stream side loafing areas account for less than 2.7 percent of the surface area of strips along the stream channel but can contribute up to 72 percent of the sediment and 55 percent of the total phosphorus during a major rainfall event. Fencing out livestock by providing armored access points and narrow live fences composed of various shrubs (fencing out livestock) could dramatically reduce those

Wildlife Researchers have found riparian buffers provide more diverse habitat for birds than the surrounding agricultural landscape. The added bonus of increasing wildlife diversity may encourage more landowners to adopt buffers, they say.

Prairie ISU researchers also are studying an area slowly being restored to natural prairie to see the effect of this change on adjacent streams. Stay tuned.

Sources: Palmer, J. 2008. An assessment of riparian land-use and channel condition impacts on streambank eroding lengths and recession rates in two third order rural watersheds in Central Iowa. Iowa State University. M.S. thesis.

Tufekcioglu, M., T.M. Isenhardt, J.R. Russell, J.L. Kovar, and R.C. Schultz. 2008. Assessment of watershed and site-specific characteristics in relation to streambank erosion. ASA-CSSA-SSSA Annual Meeting, Oct. 5-9, Houston, Texas. Poster.

UMCA UPLAND BUFFER RESEARCH

Research focus is to quantify environmental benefits of woody/grass buffers on non-point source pollutants.

Antibiotics In 2008, researchers found soils beneath vegetative buffers took up more antibiotics than cropland soil. This means less antibiotics should make their way to bodies of water when buffers are interspersed between farmland and streams. Veterinary antibiotics are used to promote health and growth in feed animals at larger production facilities, but subsequently enter the soil through field-applied manure. Future studies will look at not just the antibiotics themselves, but the drugs contained within manure, to see if this influences the fate and transport of the pharmaceuticals.

Source: Bei, C., K.W. Goyne, S.H. Anderson, R.P. Udawatta, and C.H. Lin. 2008. Veterinary antibiotic sorption to agroforestry buffer, grass buffer and cropland soils. Annual Meetings, Houston, Texas, Oct. 5-9. American Society of Agronomy, 677, South Segoe Road, Madison, Wis. Abstract.

Dissolved Organic Carbon While many studies have shown reductions in pollutant export from agroecosystems where vegetative buffers have been implemented, UMCA researchers wondered if buffer strips may actually contribute to surface water pollution by taking up excess nutrients, becoming a source of dissolved organic carbon. However, their research shows this is not the case; grass buffer strips are an effective conservation practice for reducing runoff and do not contribute to dissolved organic carbon contamination of surface waters.

Source: Veum, K.S., K.W. Goyne, P. Motavalli, R.P. Udawatta, and H.E. Garrett. 2008. Buffer effects on runoff and dissolved organic carbon loss in a corn-soybean rotation using a paired watershed approach. Annual Meetings, Houston, Texas, Oct. 5-9. American Society of Agronomy, 677, South Segoe Road, Madison, Wis. Abstract.

ATRAZINE An organic compound and widely used herbicide. Its use can be controversial due to surface and groundwater contamination and possible effects on non-target species, such as amphibians.

Enzymes, Genes, Bacteria

UMCA researchers have found perennial vegetative areas have greater enzyme activities and higher concentrations of carbon and nitrogen. This indicates greater mineralization rates, carbon accumulation and degradation of agri-chemicals in those areas as compared to annual crop areas.

EXPLODING WITH IDEAS UMCA researchers have found warm-season grasses, such as switchgrass and eastern gammagrass, aid in degrading munitions explosives such as TNT and RDX. Now they are exploring the potential synergistic effects of introducing explosive-degrading bacteria into the rhizosphere (root zone) of warm-season grasses to further enhance degradation capabilities.

Sources: Lin, C.H., J. Yang, H. Yang, R.N. Lerch, A.L. Spohn, and H.E. Garrett. 2008. Bioremediation of munitions explosives TNT and RDX by selected native grass species. SSSA-ASA-CSSA 2008 annual meeting, Oct. 5-9, Houston, Texas. Abstract.

Yang, J., C.H. Lin, H. Yang, R.N. Lerch, A.L. Spohn, and H.E. Garrett. 2008. Introduction of biological agents for enhancing rhizodegradation of munitions explosives and degradates. The Fifth International Phytotechnology Conference. Oct. 22-25. Nanjing, China. Abstract.

Preliminary results suggest buffer systems tend to harbor bacteria with atrazine degradation genes. In addition, research shows the establishment of native warm-season grass buffers could provide desired reductions in herbicide transport with less land taken out of production. Introducing atrazine-degrading bacterium into rhizospheres rapidly enhanced the rates of atrazine degradation. The majority of atrazine was transformed into harmless carbon dioxide within 72 hours of inoculation. Growth chamber and greenhouse results indicate expression of degradation genes were stimulated by 30 to 60 percent in eastern gammagrass and switchgrass rhizospheres during 100-day incubation periods. Successful introduction of this biological agent into these warm-season grass buffers could have great potential to rapidly transform the deposited atrazine into less toxic and less mobile degradation products.

Source: Lin, C.H., R.N. Lerch, H.E. Garrett, and M.F. George. 2008. Phytoremediation of atrazine by five forage grass species: Transformation, uptake and detoxification. Journal of Environmental Quality 37: 196-206.

FLOOD TOLERANCE

The Flood Tolerance Laboratory (FTL) at the Horticulture and Agroforestry Research Center was constructed along Sulphur Creek in the Missouri River floodplain. The lab has 24 channels, each approximately 6 meters wide by 80 meters long. Each channel can be independently adjusted for water depth, standing or flowing water and duration of flooding.

Researchers are looking at soybeans, sweet sorghum, oaks and other hardwood planting stock for flood and/or waterlogging tolerance. In addition, studies are measuring the production of phenolics in soil as affected by flooding and how these phenolics affect survival and growth.

Agroforestry practices can be used in floodplains to re-establish trees and herbaceous species, and to restore riparian vegetation.

Source: Unger, I.M., R.M. Muzika, P.P. Motavalli, and J. Kabrick. 2008. Evaluation of continuous In Situ monitoring of soil changes with varying flooding regimes. Communications in Soil Science and Plant Analysis 39(11-12): 1600-1619.

SWEET SORGHUM

Sweet sorghum has the potential to contribute significantly as a feedstock for renewable fuel production. Unlike starch-based biofuels such as corn, no fermentive pretreatment is required to produce the substrates (such as glucose, sucrose, fructose) for ethanol production. Further, large quantities of biomass are produced that also could contribute to renewable fuel production. In addition, one of the primary advantages of sweet sorghum is its tolerance of poor site conditions. It can be grown on drier sites not suitable for corn production, and, researchers hope, on sites prone to periodic flooding or waterlogging.

UMCA researchers Drs. Felix Fritschi and James Houx planted 12 varieties of sweet sorghum at two planting dates in the summer of 2008. Although data is still being analyzed, sweet sorghum did not appear to be impacted by flooding, as no plants died during or following flooding. Larger plants from the first planting date appeared to be less impacted than smaller ones.

OAKS

The establishment of tree species to provide food, such as acorns, for wildlife on flood-prone, riparian sites in Missouri can be a challenging task. Making sure these species will survive is important for improving both water quality and wildlife habitat.

UMCA researchers have been looking to see if different oak seed sources produce seedlings better suited to flood-prone areas. That is, whether seed taken from oaks occupying lower lying sites, rather than upland sites, would have better genetic tolerance to flooding.



The study has shown there is genetic variation in flood tolerance both among and within oak species native to Missouri. However, within-species flood tolerance is not related to stand origin (upland vs. bottomland) but, rather, it is based at the seedlot (mother tree) level. As a result, there should be opportunities to exploit this variation through traditional tree improvement techniques.

Currently, all seedlots sown in 2007 in the FTL are also growing in HARC's Missouri Gravel Bed and will be used as a source of seedlings for establishing a "flood tolerant" seedling seed orchard in either 2009 or 2010. In collaboration with David Gwaze, Missouri Department of Conservation, this orchard will serve as a source of acorns for reforestation seedlings to establish new riparian buffers in Missouri.

Sources: Coggeshall, M.V. 2008. Evaluating flood tolerance measures for Missouri oak species. Ph.D. dissertation. University of Missouri. 84 p.

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'A Farm is a Place to Live'

The University of Missouri Center for Agroforestry is dedicated to keeping the family farm sustainable, profitable and beautiful – truly a place to call home. The Center supports comprehensive research on the many facets of agroforestry, including windbreaks, forest farming, silvopasture, riparian forest buffers and alley cropping. And, when our research yields findings that could help landowners, we pass them along directly, through publications, newsletters, workshops and meetings. Everything we do is with the end goal of helping landowners get the most from their land, while at the same time sustaining the land for future generations.

Our research extends from the field, to the lab, to the markets, to the bottom line; we want landowners to have all the information possible in front of them when looking into which agroforestry practices and specialty crops might be beneficial to their farms.

This year we began studying sweet sorghum, for example. This potential biofuel is fairly adaptable and UMCA researchers want to know if it can be grown on flood-prone sites that may not be usable otherwise. This will give landowners just one more option – and a profitable and sustainable one at that – when planting a riparian area.

The University of Missouri Center for Agroforestry – keeping the family farm alive and thriving.

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In 2008, UMCA...

Published updated shiitake mushroom growing guide featuring new UMCA research to aid growers (pg. 13)

Began test marketing pawpaw, a native Missouri tree with potential as a specialty crop for the diverse family farm (pg. 14)

Found that attending the Missouri Chestnut Roast fall festival makes people much more likely to purchase chestnuts (see pg. 15)

Found alleycropping has a positive effect on beneficial insect populations, regardless of crops or row sizes used (pg. 16)

Began testing the ability of trees and shrubs to block odors around large confined animal production facilities (pg. 17)

Initiated long-term studies to see if dwarfing rootstocks are profitable for chestnut and black walnut growers (pg. 18)

Launched Web site where potential growers can compare black walnut cultivars side-by-side (pg. 19)

Found preliminary evidence that potential biofuel crop sweet sorghum can be grown on flood-prone sites (pg. 22)